

REMARKS

In view of the above amendments and following remarks, reconsideration and further examination are requested.

The specification and abstract have been reviewed and revised to make editorial changes thereto and generally improve the form thereof, and a substitute specification and abstract are provided. No new matter has been added by the substitute specification and abstract.

The instant invention pertains to an apparatus and a method for pulling a single crystal.

In accordance with a first aspect of the invention, as shown in Figures 1-2(c) for example, the apparatus comprises a crucible 21 to be charged with a melt 23, and an auxiliary heating device 16. The auxiliary heating device 16 includes a heating section 16a to be located so as to surround a seed crystal 35 at a position above and near the melt 23, and a covering section 16d, extending from the heating section, to cover a clearance between the heating section and the seed crystal. The significance of having the covering section 16d extend from the heating section 16a so as to cover the clearance between the heating section and the seed crystal 35 is that the covering section inhibits heat radiation to above the heating section, whereby a radial temperature distribution of the seed crystal can be made smaller. This allows for a shape of a growth interface at a lower end of the seed crystal to be downwardly convex, allows for thermal stress to be reduced, and allows for prevention of induction of dislocations, whereby a single crystal can be pulled without propagating dislocations. Claim 8 is representative of this aspect of the invention.

In accordance with a second aspect of the invention, as shown in Figures 5-6(c) for example, the apparatus comprises a crucible 21 to be charged with a melt 23, and an auxiliary heating device 15. The auxiliary heating device 15 includes a heating section 15a to be located so as to surround a seed crystal 35 at a position above and near the melt 23, with the heating section having a vertically lower area A and a vertically upper area E. A heating strength of the vertically lower area A is greater than a heating strength of the vertically upper area E. The significance of having the heating strength of the vertically lower area A be greater than the heating strength of the vertically upper area E is that this allows a peak of a heating distribution to be shifted to a vertically lower level of the heating section 15a. Such shifting allows for a vertical temperature gradient in the heating section

15a to be made larger, whereby formation speed of a neck is increased. Claim 20 is representative of this aspect of the invention.

In accordance with a third aspect of the invention, the method utilizes the apparatus of the second aspect wherein a heating power of the heating section is within a range of from 30% to 80% of a heating power necessary for enabling melting of a surface of a front portion of the seed crystal when the seed crystal is dipped into the melt so as to form a neck. The significance of having the heating power be within such a range is that this allows to be maintained a temperature gradient required for excluding dislocations from a solid-liquid interface, along with a balance between a temperature of the melt directly beneath the heating section and a temperature at an outer region of the melt. Accordingly, thermal stress in the neck is reduced and development of dislocations in the neck is prevented, whereby dislocations can be excluded from the crystal during growth of the neck. Claim 26 is representative of this aspect of the invention.

Claims 1-7 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Kubota et al. This rejection is respectfully traversed, and Kubota et al. is not applicable with regard to the newly added claims for reasons to follow. Prior to discussing the rejection, please note that new independent claim 8 basically corresponds to former claim 1, new independent claim 20 basically corresponds to former claim 5, and new independent claim 26 basically corresponds to former claim 7. Accordingly, the rejection based on Kubota et al. will be addressed as it pertains to each of independent claims 8, 20 and 26.

Claim 8

Former claim 1 and new claim 8 each require an apparatus for pulling a single crystal that comprises a crucible and an auxiliary heating device, wherein the auxiliary heating device includes a heating section to surround a seed crystal, and

**a covering section extending from the heating section
so as to cover a clearance between the heating section and
the seed crystal when surrounded by the heating section.**

Such a covering section is shown as 16d or 16d₂ in Figures 2(c) or 3(c), for example.

Kubota et al. does not disclose or suggest such a covering section. In this regard, though the after heater 19 of Kubota et al. does include a heating section, there is no portion of this heater that can reasonably be said to correspond to the covering section as claimed. Indeed, the Examiner has not equated any portion of the apparatus Kubota et al. with the claimed covering section. Furthermore, in order for some structure of the apparatus of Kubota et al. to be reasonably equated to the claimed covering section, this structure would have to be positioned in or above a space between crystal 13 and the heater 19. No such structure exists, and accordingly, claim 8 is allowable over Kubota et al.

Claim 20

Former claim 5 and new claim 20 each recite an apparatus for pulling a single crystal that comprises a crucible and an auxiliary heating device, wherein the auxiliary heating device includes a heating section

**having a vertically lower area and a vertically upper area,
with a heating strength of the vertically lower area being
greater than a heating strength of the vertically upper area.**

Such areas are shown as A and E in Figure 6(b) for example.

Kubota et al. does not disclose or suggest upper and lower areas having such relative heating strengths. In this regard, there is no discussion in Kubota et al. of the after heater 19 having two areas with different heating strengths. Indeed, the Examiner has failed to equate any portions of after heater 19 with the claimed areas having different heating strengths. Thus, claim 20 is allowable over Kubota et al.

Claim 26

Because claim 26 requires use of the apparatus of claim 20, claim 26 is allowable over Kubota et al. for reasons analogous to those expressed above with regard to claim 20.

Additionally, certain of the dependent claims are believed to be patentable in their own right. In this regard, new claim 14 recites that the covering section extends from the heating section

towards an axis of a passageway defined by the heating section. Kubota et al. fails to disclose any structure that can reasonably be said to correspond to such a covering section, and accordingly, claim 14 is patentable in its own right.

Similarly, new claims 24 and 27 are patentable in their own right because these claims require that the heating section has two distinct thicknesses. Nowhere does Kubota et al. disclose or suggest that after heater 19 has an upper portion of a first thickness and a lower portion of a second different thickness. Thus, claims 24 and 27 are patentable in their own right.


If the Examiner continues to reject the claims as being unpatentable over Kubota et al., then the Examiner is respectfully requested to specifically identify that structure which corresponds to the covering section as recited in claim 8, and those portions of Kubota et al. that correspond to the vertically upper area and vertically lower area as recited in claims 20 and 26.

In view of the above amendments and remarks, it is respectfully submitted that the present application is in condition for allowance and an early Notice of Allowance is earnestly solicited.

If after reviewing this Amendment, the Examiner believes that any issues remain which must be resolved before the application can be passed to issue, the Examiner is invited to contact the Applicants' undersigned representative by telephone to resolve such issues.

Respectfully submitted,

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